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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 3 :
H01R 13/20

A1

(11) International Publication Number: WO 85/ 05500

(43) International Publication Date: 5 December 1985 (05.12.85)

(21) International Application Number: PCT/US85/00873

(22) International Filing Date: 14 May 1985 (14.05.85)

(31) Priority Application Number: 609,747

(32) Priority Date: 14 May 1984 (14.05.84)

(33) Priority Country: US

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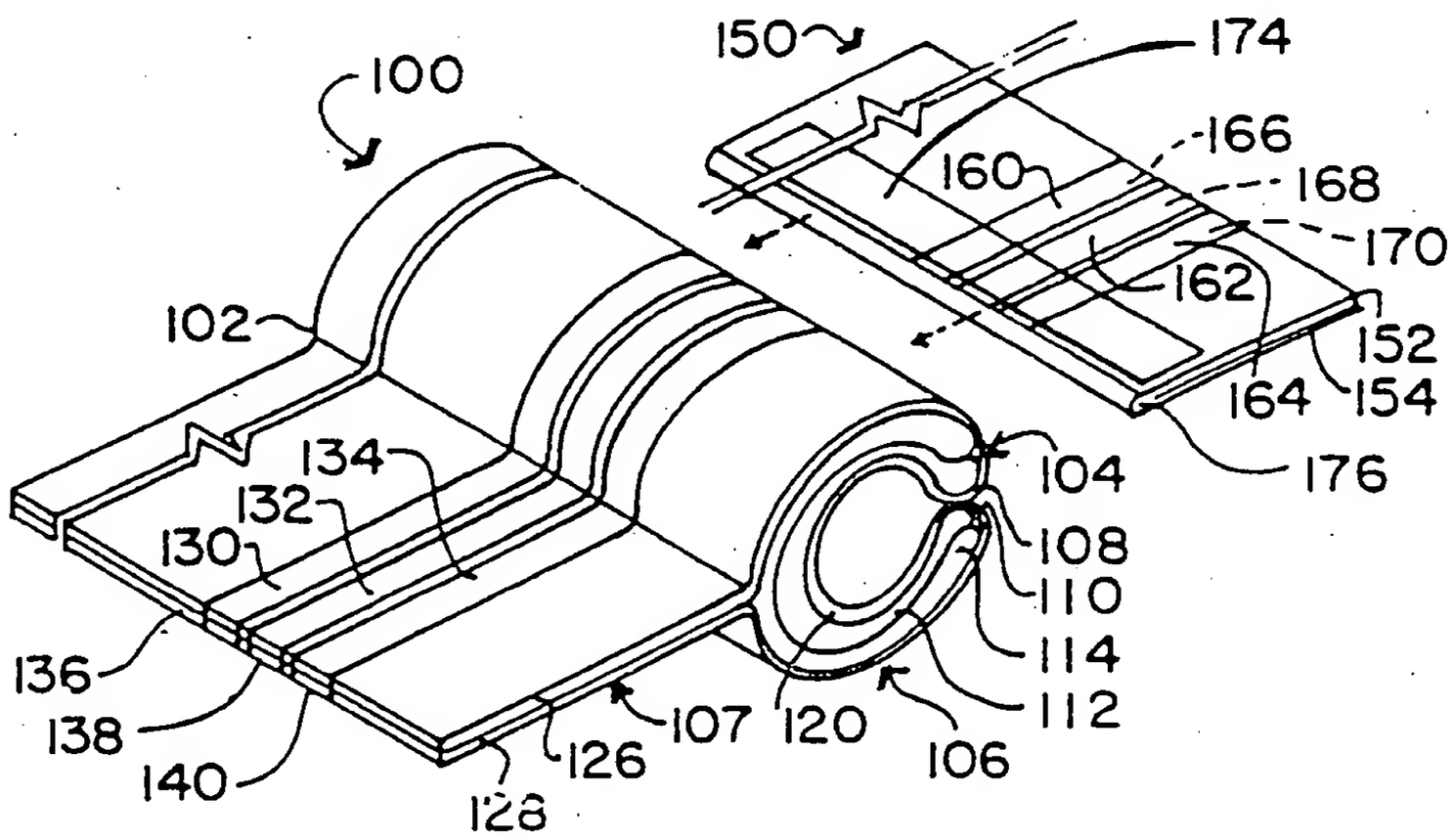
(81) Designated States: AU, DE (European patent), FR (European patent), GB (European patent), IT (European patent), JP, KR, NL (European patent).

Published
With international search report.

(54) Title: THERMALLY RESPONSIVE ELECTRICAL CONNECTOR



(57) Abstract

A common problem in the art of connecting two electrical components is the providing of a convienient and effective zero insertion force coupling therebetween especially where a plurality of parallel conductors along one component are to be connected with a corresponding plurality along the other. The present apparatus (100) and method address this problem by providing a split tube edge along one of the two (100, 150) electrical components, the split tube (104) including a memory shape material (112) therein. When the split tube (104) is opened, the second electrical component (150) is inserted therein whereupon the split tube can be closed. Conductors (130-140) along the split tube (104) make contact with corresponding conductors (160-170) along the second component (150) when the tube (104) is closed. The memory shape material (112) in the split tube (104) acts to either open (Fig. III) the split tube or close (Fig. V) the split tube when the material (112) reaches a characteristic transition temperature.

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THERMALLY RESPONSIVE ELECTRICAL CONNECTOR

BACKGROUND OF THE INVENTION

It is often necessary to connect or disconnect conductors (or contacts) along one electrical component with corresponding conductors (or contacts) along another electrical component.

Moreover, it is often desired that such connection (or disconnection) be convenient, effective and performable in an area inaccessible by tools.

It is also often desired that connection (or disconnection) be effectuated with a zero insertion (or removal) force. This feature may be required to prevent damage to the components being connected.

In addition, it is typically desired in numerous applications of electrical connectors to provide connection between closely spaced parallel conductors; to provide high strength closure; and high resistance to shock and vibration. Conventional approaches which teach separate coupling elements for each conductor on one component to be connected to a corresponding conductor on a second component have rendered such features difficult to attain.

SUMMARY OF THE INVENTION

In accordance with the invention, an electrical connector is provided which realizes the aforementioned features as objects.

The present invention relates preferably to a multipin electrical connector including (a) male member having a plurality of conductors thereon extending longitudinally in parallel and (b) a female member that includes a split tube to receive the male member. A plurality of parallel conductors on the female member extend along the inside of the split tube which receives the male member. A plurality of parallel conductors on

the female member extend along the inside of the split tube are spaced to correspond with the conductors along the male members. The male member has an enlarged edge that is insertable into the split tube so that each conductor along the inside of the split tube faces a corresponding conductor along the enlarged edge of the male member. The split tube comprises Nitinol or some other shape memory material which is biased open (or closed) and which, upon heating to a transition temperature, changes dimensions to engage (or disengage) the inserted male member.

Such a connector features zero insertion force, high strength, close conductor spacing, and high shock resistance. Upon closure, the conductors along the male member contact corresponding conductors along the split tube.

Preferably, the invention pertains to an electrical connector for coupling two strips together. The first strip has a split tube forming one edge thereof, the split of the tube being selectively opened and closed. The second strip is inserted into the split when the tube is open, whereupon the tube may be closed to effect coupling of the two strips.

In accordance with the invention, the second strip may include at least one conductor therealong which is to be coupled to a corresponding conductor along the first strip. Typically, parallel conductors on the upper surface and on the lower surface of the second strip are couplable to corresponding conductors of the first strip by closure of the split tube thereagainst.

In one embodiment, the conductors along the upper surface of the second strip are separate and indpendent from the conductors along the lower surface thereof. Also, conductors along the first strip can similarly be defined with (a) an upper plurality of conductors that can close against conductors along the second strip upper surface and (b) a lower plurality of conductors independent of the upper plurality that can close against conductors along the second strip lower surface. Hence, a double connector is provided wherein a plurality of con-

nections can be effected in an upper plane separately and distinct from connections effected in a lower plane. That is, where x conductors are provided along the upper surface and x conductors are provided along the lower surface of the second strip, 2x connections can be made.

In a second embodiment, conductors along the upper surface of the second strip extend into the conductors along the lower surface. Similarly, the upper plurality of conductors of the first strip may extend into the lower plurality of conductors. This is a single connector embodiment. This arrangement provides an upper area and a lower area of electrical contact for each conductor.

Hybrid embodiments which vary from the above two embodiments -- the single connector and double connector -- may include maintaining some of the conductors on the upper surface of the second strip independent of the conductors on the lower strip while other conductors on the upper strip extend into conductors on the lower strip.

Also, it is envisioned that all conductors along the upper strip extend into the conductors along the lower strip of the second strip whereas all conductors in the upper plurality of the first strip do not extend into conductors in the lower plurality. Accordingly, two sets of lines connected respectively to the upper plurality of the first strip and to the lower plurality of the first strip may be interconnected upon closure against the second strip, as well as providing connection between the conductors on the first strip and second strip.

In the various embodiments it is contemplated that the split tube include at least a shape memory layer formed, preferably, of a shape memory metal such as a nickel titanium alloy. More specifically, it is preferred that the split tube comprise coaxial layers which include a shape memory layer, a stainless steel layer disposed about the shape memory layer, and a flexible plastic layer -- into which conductors are imbedded -- enclosing the split tube. Depending on how heat is applied to the shape memory layer, a heater element may be provided adjacent the shape memory layer along the portion of the flexible plastic layer which inscribes the split tube.

To provide a locked coupling, the edge of the second strip inserted into the interior of the split tube is enlarged.

In accordance with the invention, closure of the connector is performed by heating a shape memory layer to characteristic transition temperature. It is, however, contemplated that opening of the connector may also be performed by heating a shape memory layer to a characteristic transition temperature. It is known that a shape memory metal in its memory shape displays high strength; thus the closure or opening to a memory shape results in a high strength configuration.

BRIEF DESCRIPTION OF DRAWINGS

Figure I is an upper back left perspective view illustrating a connector according to the invention.

Figures II through V are side-view illustrations showing the operation of the connector of Figure I.

Figure VI is an illustration of one embodiment of an element formable into a first strip shown in Figure I.

Figure VII is an illustration of one embodiment of an element formable into a second strip shown in Figure I.

Figure VIII is an upper front left perspective view of a double connector formed from the first strip of Figure VI and the second strip of Figure VII.

Figure IX is an alternative embodiment of an element formable into a second strip shown in Figure I.

Figures X and XI are perspective and side view illustrations of the invention including a cover.

DESCRIPTION OF THE INVENTION

In Figure I, one embodiment of an electrical connector 100 according to the invention is illustrated.

The connector 100 is shwon including a first strip 102 which terminates in a split tube 104. The split tube 104 is shown formed of a plurality of coaxial layers.

Extending peripherally about the split tube 104 is a flexible plastic layer 106 which serves to inscribe and circumscribe the split tube 104. That is, the flexible plastic layer 106 extends along a flat two-layer portion 107 of the first strip 102, passes circumferentially to an upper lip 108 whereupon the plastic layer 106 traces the inner surface of the split tube 104 to a lower lip 110. From the lower lip 110, the plastic layer 104 follows the lower outer circumference of the split tube 104 back to the flat portion 107 of the first strip 102. The flat portion 107 comprises two plastic layers that lie against each other as a laminate.

The split tube 104 also includes a shape memory layer 112 about which is disposed another layer 114. The layer 114 is preferably stainless steel. The shape memory layer 112 and layer 114 are enclosed by the flexible plastic layer 106.

Provided along the inscribing portion of the flexible plastic layer 106 is a flexible heater 120 of a construction known in the art. The heater 120 is adjacent the shape memory layer 112 to direct heat thereto.

Also provided along the flexible plastic layer 106 are parallel conductors 130, 132, and 134 (the number being variable) along the upper layer 126 of the first strip 102. Along the lower layer 128 of the first strip 102 are parallel conductors 136, 138, and 140. Each conductor 130 through 134 extends along the flat portion 107 to follow an outer circumscribing path toward and around the upper lip 108. Each conductor 136 through 140 follows a similar path along the lower layer 128 of the first strip 102. As discussed below, the conductors 130 through 134 along the upper layer 126 may or may not extend into corresponding conductors 136 through 140 along the lower layer 128 depending on embodiment.

Preferably, the conductors 130 through 140, as well as the heater 120, are embedded in the flexible plastic layer 106 to enhance durability, shock and impact resistance, integrity of structure, and strength and to maintain the relative positions of conductors and heater strips. That is, the conductors 130 through 140 and

heater 120 are covered by plastic layer 106. To expose the conductors to permit electrical contact therewith -- as by pressing another conductor thereagainst -- windows are provided in the plastic layer 106 where contact is to be made. As described below, the windows expose at least those portions of the conductors 130 through 140 along the upper lip 108 and the lower lip 110. The space therebetween, it is noted, defines the split of the tube 104 between which a second strip 150 is insertable.

The second strip 150 includes two flexible plastic layers 152 and 154 lying coextensively against each other. The upper layer 152 has conductors 160 through 164 therealong. The lower layer 154 also has conductors 166 through 170 (not shown) extending theralong. To expose the conductors 160 through 164, a window 174 is provided in the upper layer 152. A similar window is preferably provided in the lower layer 154 also.

The second strip 150 also includes an enlarged edge 176 which is insertable into the interior of the split tube 104. (The edge 176 is enlarged by inserting a rod or the like between the two layers 150 and 152 at the fold therebetween.) By enlarging the edge 176, the two strips 102 and 150 cannot be pulled apart after the split tube 104 is closed with the edge 176 inserted. Specifically, the edge 176 preferably abuts the upper lip 108 and the lower lip 110 upon closure to effectuate the desired locking effect.

The connector 100 in Figure I is shown with the split tube 104 closed. To enable the second strip 150 to be inserted, the split tube 104 is deformed to open the split. In this regard, it is noted that the shape memory layer 112 may serve to either open the tube 104 from a closed position or close the tube 104 from an open position. Whether the shape memory layer 112 acts to open or to close the tube 104 depends on the memory shape imparted to the layer 112. The shape memory layer 112 comprises a material that can be formed to a predefined memory shape or configuration. After the memory shape is defined, the material can be deformed and, by bringing the material to a characteristic transition temperature,

returned (or recovered) to the memory shape. Although various plastics feature heat recoverable memory, it is preferred that the shape memory layer 112 be a metal which undergoes transition such as a nickel titanium alloy, or Nitinol.

The operation of Nitinol and other alloys which exhibit such memory or recovery from a heat unstable state is discussed in various references and is not elaborated on here. Reference is made, however, to U.S. Patent No. 3,606,592 to Madurski et al and to U.S. Patent No. 4,018,547 to Rogen which describe the shape memory phenomenon and are incorporated herein by reference. In brief, Nitinol has a temperature above which the memory configuration is set. By holding the Nitinol to a given shape at such temperature (e.g. approximately 900°F for 55-Nitinol), the memory configuration becomes fixed. Nitinol also has a transition temperature range (TTR) below which the alloy is ductile and may be plastically deformed and above which recovery occurs. Raising the alloy to temperatures above the TTR, then, causes atoms of the alloy displaced during deformation to return their predeformed positions. Accordingly, Nitinol and similar alloys characterized with memory shape can be repeatedly deformed and recovered in alternation by applying pressure to the Nitinol when below the TTR and by heating the alloy to recovery temperatures thereafter. As is known in the art, the TTR, or recovery temperatures, may be determined between -60°F and +300°F by proper selection of alloy.

In the preferred mode, the shape memory layer 112 acts to open the tube 104. The tube 104 is closed by a spring force provided by the layer 114. The spring force is sufficient to close the tube 104 when the shape memory layer 112 is ductile and soft (below the transition temperature of Nitinol, for example) but is overpowered by the shape memory layer 112 upon recovery thereof. Alternatively, although not preferred, the tube 104 may be deformed closed by means of a tool, if the layer 114 is not desired or provided.

Although the connector 100 may vary greatly in dimensions based on use, sample dimensions include: an

outer diameter of .120 inches for the tube 104 when closed, a .020 inch thickness of layer 112, a .015 inch thickness of layer 114, an inner "diameter" of the tube 104 (when open) of .022 inch and a plastic layer 106 having dimensions of a conventional flexstrip.

Figures II through V illustrate the operation of the connector 100. In Figure II, the connector 100 is closed (by the layer 114) with the upper lip 108 of tube 104 abutting the lower lip 110. In Figure III, the tube 104 is opened by heating the shape memory layer 112 to enable the second strip 150 with its enlarged edge 176 to be inserted as shown in Figure IV. The heating is provided by heater 120. Other sources of heat may also be employed. Discontinuing the heating results in the closure of the upper lip 108 and lower lip 110 with the second strip 150 therebetween. The window 174 (see Figure I) of the second strip 150 is aligned with the upper lip 102 -- and a corresponding window along the lower layer 154 (see Figure I) is also aligned with the lower lip 110 following insertion and closure. By providing windows along the upper lip 108, the conductors 130 through 134 are pressed against the conductors 160 through 164, respectively, making electrical contact therewith. Similarly, by providing windows along the lower lip 110, the conductors 136 through 140 are pressed against the conductors 166 through 170, respectively, making electrical contact therewith.

In Figure VI, one embodiment of a first strip 200 is shown before it is structured as in Figure I. Figure VI shows two windows 201 and 202 which lie along the upper lip 108 and the lower lip 110, respectively, when formed as Figure I. Connectors 204 through 216 are embedded in flexible plastic 218. These conductors 204 through 216 may be considered to lie along the "upper" layer of the first strip as illustrated in Figure I. The conductors 204 through 216 end just beyond the window 201. Conductors 224 through 236 similarly end just beyond the window 202. Also embedded in the plastic 218 is a heater element 240 with leads connectable thereto to produce heating.

Figure VII shows an embodiment of the second strip 300 formable into a structure like that shown in Figure I by folding along line K. One window 301 is shown exposing conductors 304 through 318 embedded in the "upper" layer 320 of plastic 322. Conductors 324 through 338 are provided in the "lower" layer 340 being exposed through window 302.

Figure VIII shows a perspective of a connector formed from a first strip 200 as in Figure VI and the second strip 300 as in Figure VII. Figure VIII shows a double connector wherein conductors 206' through 210' are separate from -- i.e. do not extend into -- conductors along the lower plane, e.g. conductors 224 through 236 of Figure VI, and wherein conductors 308' through 312' do not extend into conductors along the lower plane such as conductors 324 through 338 of Figure VII. Accordingly, six conductors (as illustrated) of the first strip 200' can separately and distinctly connect to six conductors of the second strip 300'. That is, there is an upper plane of connections that can be made (by pairs 206'-326', 208'-328', 210'-330') and a similar lower plane of connections that can be made.

Turning to Figure IX, a second strip 400 for use in a single connector is shown. Specifically, each conductor 406 through 420 in the upper layer 422 folds back to extend along the lower layer 424 when the second strip 400 is creased along line L-L. In the single connector, each conductor of the first strip (not shown) also extends the length of the plastic -- each conductor 406 through 420 being exposed through both windows 430 and 432 to make electrical contact with a corresponding conductor of the first strip.

Hybrid embodiments which vary from the above two embodiments -- the single connector and double connector -- may include maintaining some of the conductors on the upper surface of the second strip while other conductors on the upper strip extend into conductors on the lower strip.

Also, it is envisioned that all conductors along the upper strip extend into the conductors along the lower

strip of the second strip whereas all conductors in the upper plurality of the first strip do not extend into conductors in the lower plurality. Accordingly, two pairs of lines connected respectively, to the upper plurality of the first strip and to the lower plurality of the first strip may be interconnected upon closure against the second strip, as well as providing connection between the conductors on the first strip and second strip.

In Figures X and XI, a cover 500 is shown enclosing a tube 502 with shape memory layer 504, stainless steel layer 506, heater 508, and plastic layer 510. The cover 500 has a slot 512 for receiving the second strip 514 with a locking edge 516.

According to the invention, conductors along the first strip engaging corresponding conductors along the second strip to make electrical contact therewith. when the conductors are embedded in, or covered by, plastic windows are required to enable the contact. If the conductors lie along or protrude from the plastic rather than being embedded totally within, the windows may not be required.

I CLAIM:

1. An electrical connector comprising:

a first strip having a split tube forming one edge of said first strip, said first strip including deforming means for selectively opening and closing the split of said split tube; and

at least one conductor disposed circumferentially along the inner surface of said split tube;

said deforming means including a heat recoverable member which acts to recover said split tube to either a predefined open position or a predefined closed position in response to said heat recoverable member assuming a prescribed transition temperature.

2. An electrical connector according to claim 1, further comprising:

a second strip having at least one conductor therealong;

said second strip being insertable into the split of said split tube when open; and

said inserted second strip being couplable to said first strip in response to said split tube being closed by said deforming means with each conductor of said first strip aligned to contact a corresponding conductor of said second strip.

3. An electrical connector according to claim 2,

wherein said split tube has a plurality of coaxial layers and said heat recoverable member comprises a shape memory metal that forms one of said coaxial layers; and

wherein a second of said coaxial layers comprises a metal layer that at least partially surrounds said heat recoverable member;

said heat recoverable member opening said split tube responsive to said heat recoverable member assuming the transition temperature thereof.

4. An electrical connector according to claim 3, further comprising:

a heater proximate to said heat recoverable member;

said heater transferring sufficient heat to said heat recoverable member to elevate the temperature thereof to the transition temperature.

5. An electrical connector according to claim 4, wherein said first strip and said second strip each comprises a flexible strip, said first strip including parallel spaced conductors extending therealong and said second strip including parallel similarly spaced conductors extending therealong.

6. An electrical connector according to claim 5, wherein said first strip has an upper surface along which a first plurality of said parallel conductors extend, the conductors of said first plurality terminating at a first plurality of corresponding contacts exposed to the interior of said split tube;

wherein said first strip has a lower surface along which a second plurality of said parallel conductors extend, the conductors of said second plurality terminating at a second plurality of corresponding contacts exposed to the interior of said split tube;

wherein said second strip has a lower surface along which a fourth plurality of said parallel conductors extend, the conductors of said fourth plurality terminating at a fourth plurality of corresponding contacts each of which presses against a corresponding contact of said second plurality in response to closure of said split tube with said second strip inserted therein.

7. An electrical connector according to claim 6, wherein said second strip has an enlarged edge, said enlarged edge being disposed within said split tube when said second strip is inserted;

said enlarged edge locking said second strip in said split tube upon closure thereof.

8. An electrical connector according to claim 7, wherein each strip has a cover layer into which said conductors are embedded;

said cover layers having contact exposing windows therein to enable contacts on said first strip to press against contacts on said second strip.

9. An electrical connector according to claim 1, wherein said first strip and said second strip each comprises a flexible strip, said first strip including parallel spaced conductors extending therealong and said second strip including parallel similarly spaced conductors extending therealong.

10. An electrical connector according to claim 9, wherein said first strip has an upper surface along which a first plurality of said parallel conductors extend, the conductors of said first plurality terminating at a first plurality of corresponding contacts exposed to the interior of said split tube;

wherein said first strip has a lower surface along which a second plurality of said parallel conductors extend, the conductors of said second plurality terminating at a second plurality of corresponding contacts exposed to the interior of said split tube;

wherein said second strip has an upper surface along which a third plurality of said parallel conductors extend, the conductors of said third plurality terminating at a third plurality of corresponding contacts each of which presses against a corresponding contact of said first plurality in response to closure of said split tube with said second strip inserted therein; and

wherein said second strip has a lower surface along which a fourth plurality of said parallel conductors extend, the conductors of said fourth plurality terminating at a fourth plurality of corresponding contacts each of which presses against a corresponding contact of said second plurality in response to closure of said split tube with said second strip inserted therein.

11. An electrical connector according to claim 10,

wherein said second strip has an enlarged edge, said enlarged edge being disposed within said split tube when said second strip is inserted;

said enlarged edge locking said second strip in said split tube upon closure thereof.

12. An electrical connector according to claim 11,

wherein each strip has a cover layer into which said conductors are imbedded;

said cover layers having contact exposing windows therein to enable contacts on said first strip to press against contacts on said second strip.

13. An electrical connector according to claim 2, wherein said shape memory metal comprises a nickel titanium alloy.

14. An electrical connector according to claim 5, wherein said first strip has an upper surface and a lower surface, each conductor of said first strip extending (a) along the supper surface thereof (b) circumferentially inside said split tube with at least a portion of each conductor exposed to the interior of said split tube, and (c) along the lower surface thereof.

15. An electrical connector, according to claim 14,

wherein said second strip has an upper surface along which a first plurality of said parallel conductors extend; each conductor of said first plurality being pressed against a corresponding conductor of said first strip inside said split tube in response to closure of said split tube.

16. An elctrical connector, according to claim 15,

wherein said second strip has a lower surface

along which a second plurality of said parallel conductors extend, each conductor of said second plurality being pressed against a corresponding conductor of said first strip inside said split tube in response to closure of said split tube.

17. An electrical connector according to claim 16,

wherein each conductor of said first plurality extends into a corresponding conductor of said second plurality.

18. An electrical connector according to claim 5, further comprising:

a tubular cover for containing said first strip with said second strip coupled thereto;

said tubular cover being adjustable to different diameters.

19. An electrical connector comprising:

a split tube;

means for selectively opening and closing the split of said split tube;

at least one engaging conductor which extends to at least partially circumscribe and at least partially inscribe said split tube; and

a strip having at least one engageable conductor therealong, said strip being insertable within the split of said split tube with each engaging conductor pressing against a corresponding engageable conductor in response to closure of said split tube;

said opening and closing means comprising a shape memory metal layer within said split tube.

20. An electrical connector, according to claim 19,

wherein said opening and closing means includes said split tube which comprises a material which deforms to close the split thereof to enable strip engagement;

said shape memory metal layer acting to open said split tube when elevated to a prescribed transition temperature.

21. An electrical connector according to claim 20,

wherein said shape memory metal comprises a nickel titanium alloy.

22. An electrical connector according to claim 21,

wherein each of a plurality of engaging conductors make electrical contact with a corresponding engageable conductor responsive to closure of said split tube against said strip when inserted.

23. An electrical connector according to claim 22,

wherein said split tube has an upper lip and a lower lip defining the split of said tube therebetween; and

wherein said strip has an upper surface along which engageable conductors extend; and

wherein a portion of each engaging conductor passing along said upper lip makes electrical contact with a portion of a corresponding engageable conductor that extends along the strip upper surface in response to tube closure.

24. An electrical connector according to claim 23,

wherein said strip has a lower surface along which engageable conductors extend; and

wherein a portion of each engaging conductor passing along said lower lip makes electrical contact with a portion of a corresponding engageable conductor that extends along the strip lower surface.

25. An electrical connector according to claim 24,

wherein each engaging conductor passing along said upper lip extends into a corresponding engaging conductor passing along said lower lip, thereby forming a single continuous conductor.

26. An electrical connector according to claim 25,

wherein each engageable conductor passing along said strip upper surface extends into a corresponding engageable conductor passing along said strip lower surface, thereby forming a single continuous conductor.

27. An electrical connector according to claim 26,

wherein said strip has an enlarged edge that is insertable into the interior of said split tube;

said enlarged edge locking together said strip and said split tube upon closure.

28. An electrical connector according to claim 27, further comprising:

means for heating said shape memory metal layer.

29. A method of making an electrical connector comprising the steps of:

forming a split tube of a shape memory metal and a deformable material, the split being positioned between an upper lip and lower lip of the split tube;

setting a memory shape of the split tube to conform to an open configuration of the split tube;

applying parallel engaging conductors to the split tube including the step of extending each conductor of a first plurality of conductors circumferentially about and along the upper lip of the split tube;

forming a strip with engageable conductors therealong; and

positioning the engaging conductors of the first plurality and the engageable conductors of the strip

to be in alignment to enable each engaging conductor of the first plurality at least along the upper lip to make electrical contact with a corresponding aligned engageable conductor of the strip upon closure.

30. A method according to claim 29, wherein the step of applying engaging conductors includes the further step of:

extending each conductor of a second plurality of conductors circumferentially about and along the lower lip of the split tube; and wherein the method comprises the further step of:

positioning the engaging conductors of the second plurality and engageable conductors of the strip to be in alignment to enable each engaging conductor of the second plurality at least along the lower lip to make electrical contact with a corresponding aligned engageable conductor upon closure.

31. An electrical connector according to claim 29, including the further step of:

positioning a selectively actuatable heater proximate to the shape memory metal to transfer heat thereto.

FIG. I

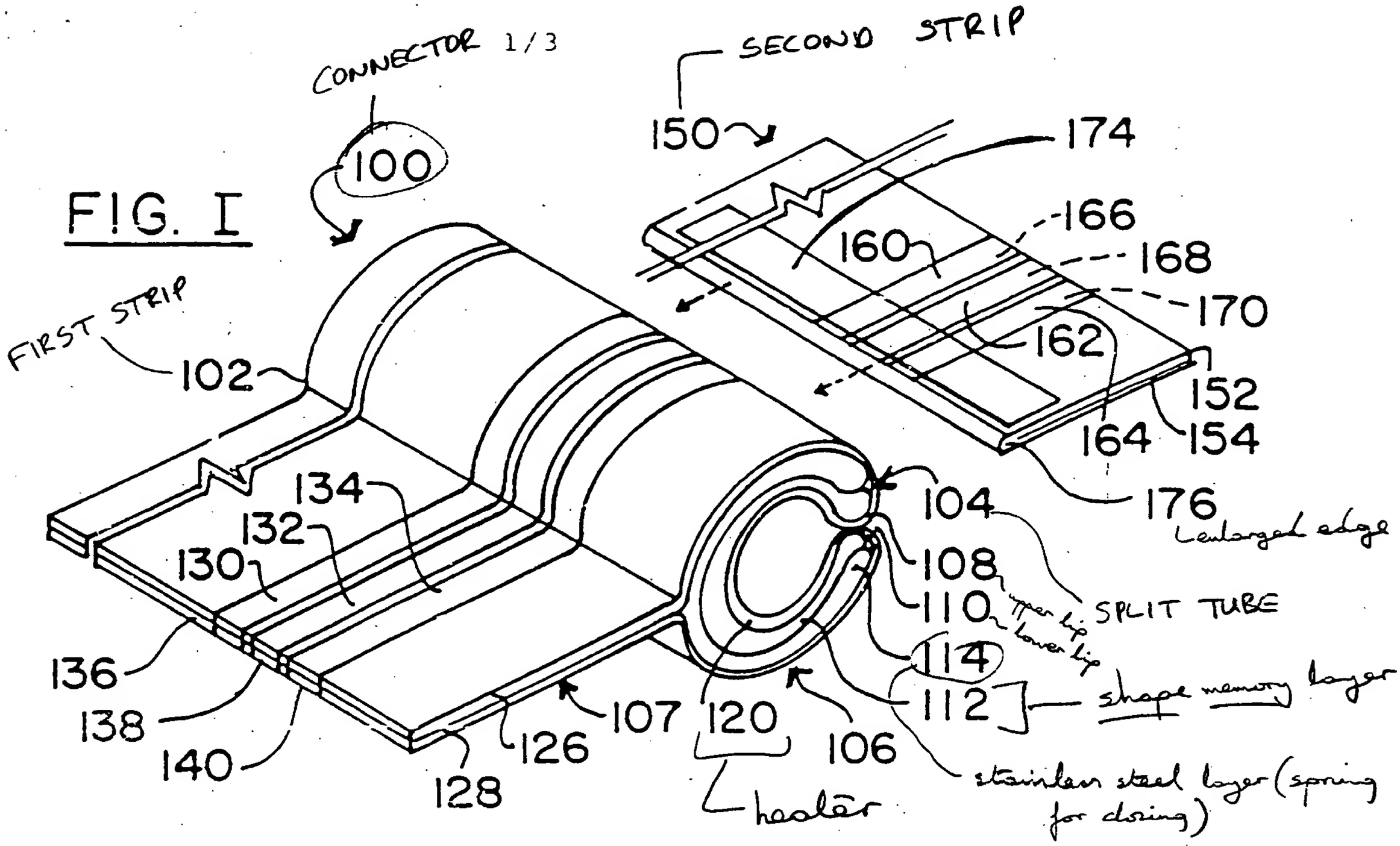


FIG. II

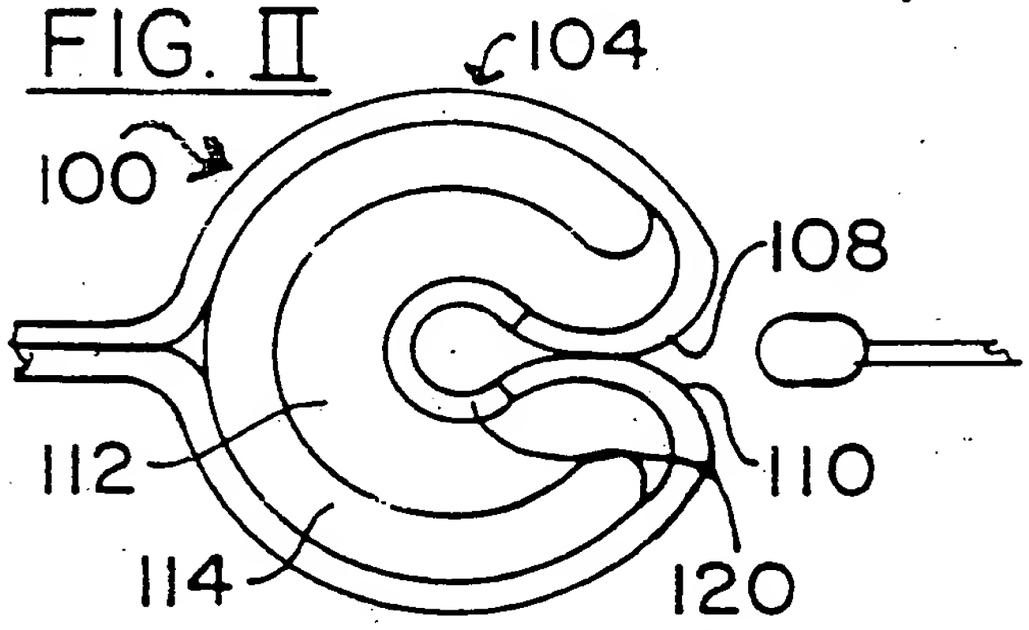


FIG. III

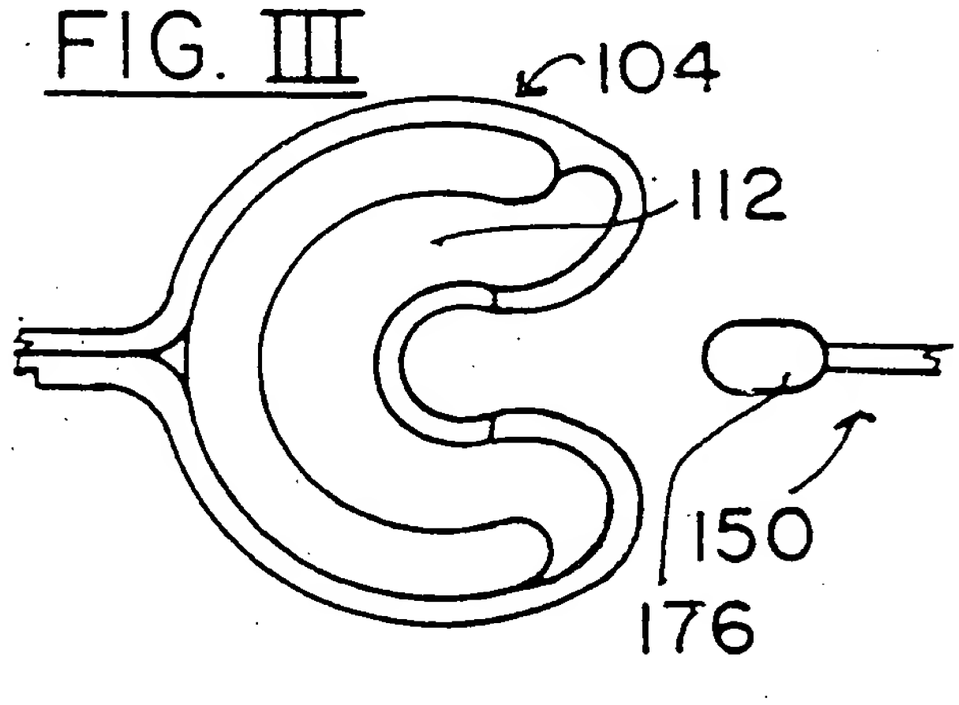


FIG. IV

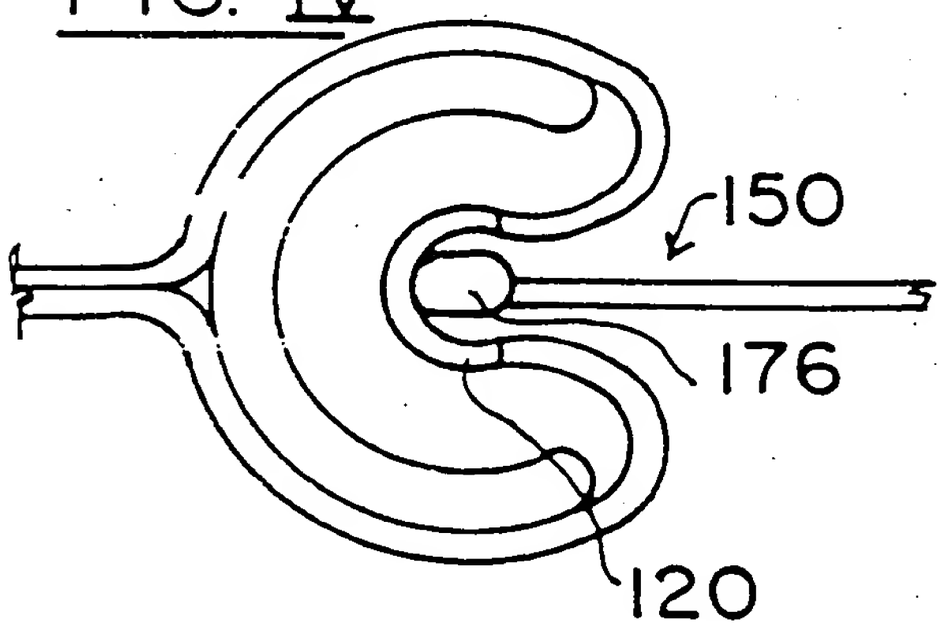


FIG. V

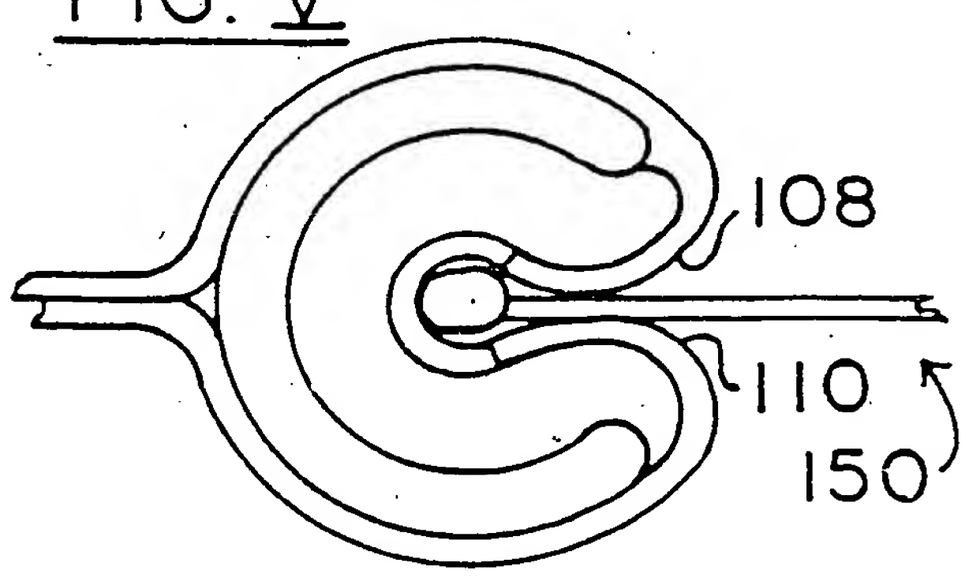


FIG. VI

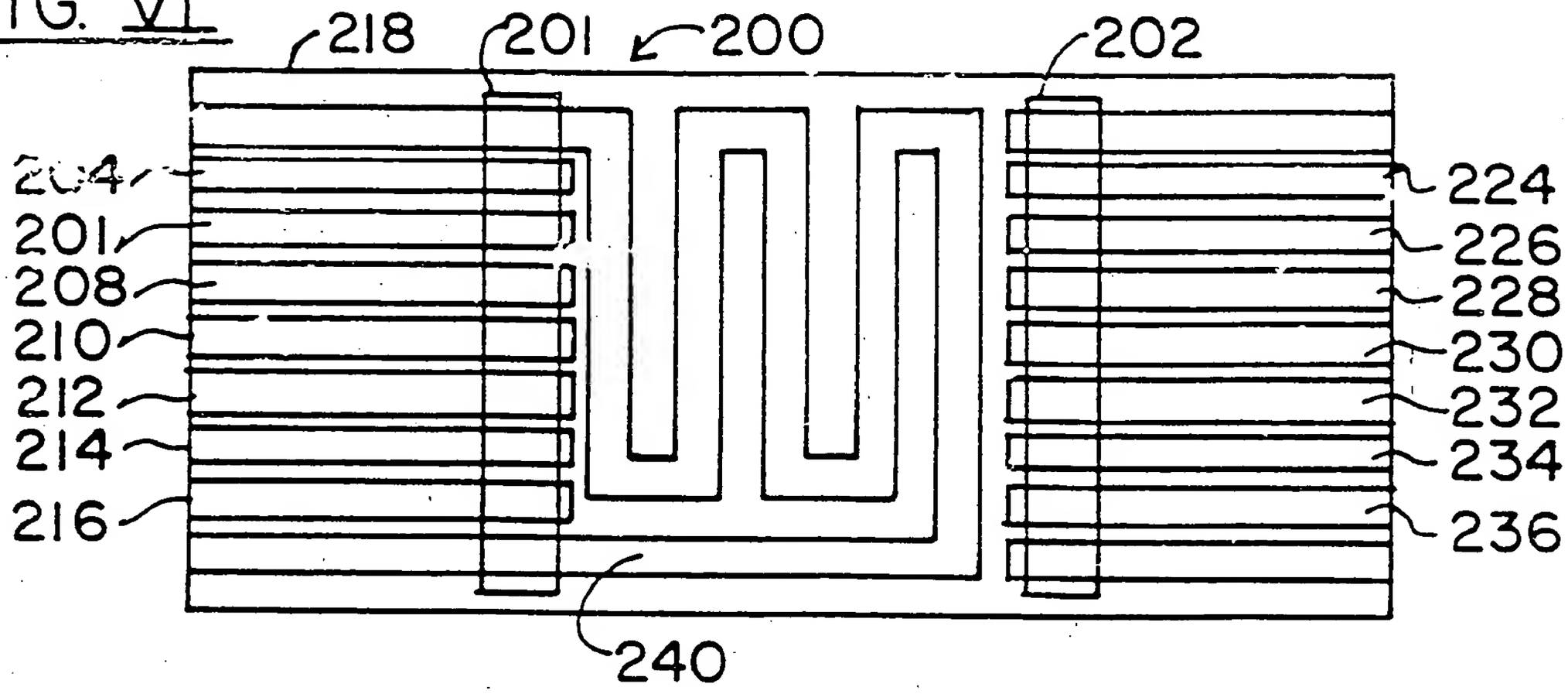


FIG. VII

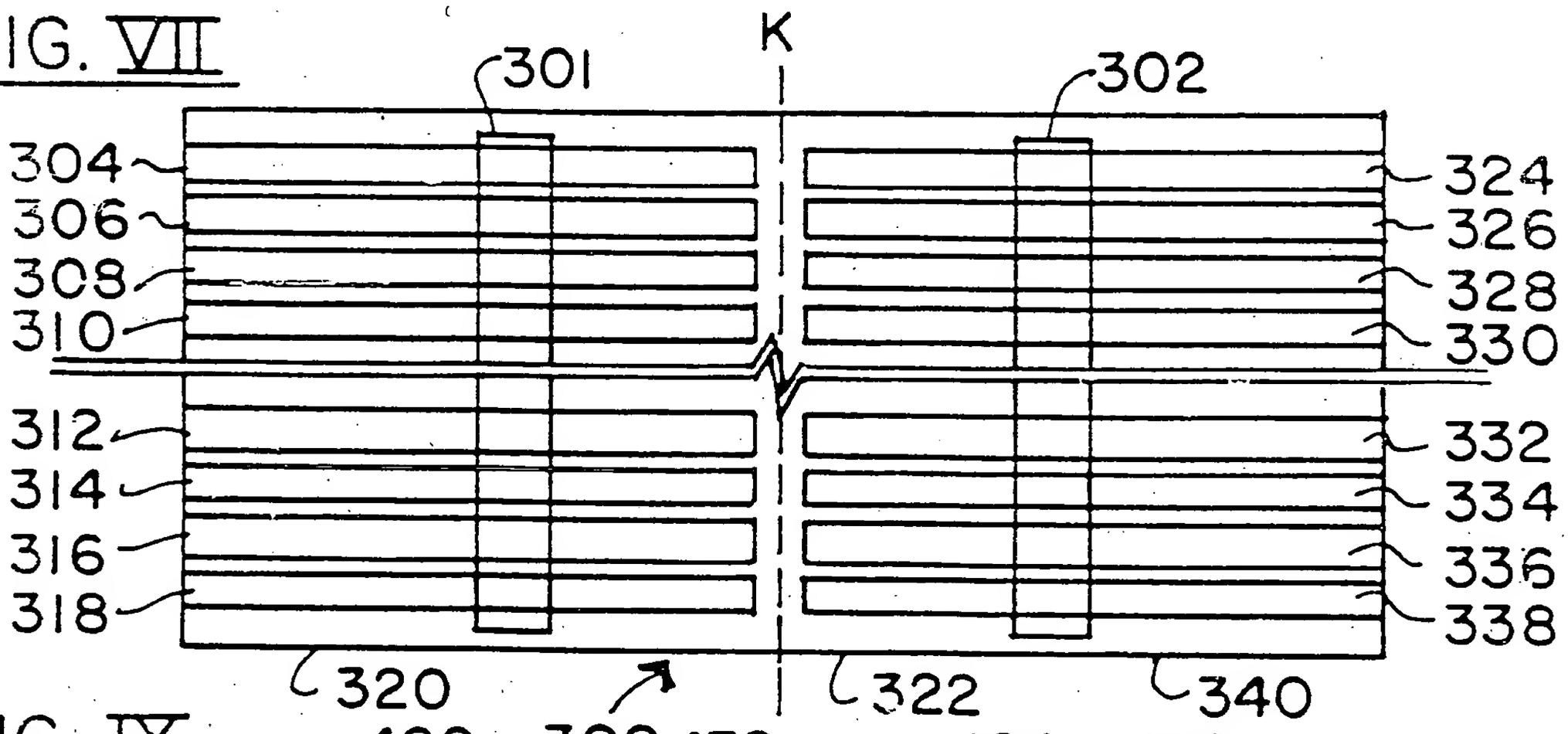


FIG. IX

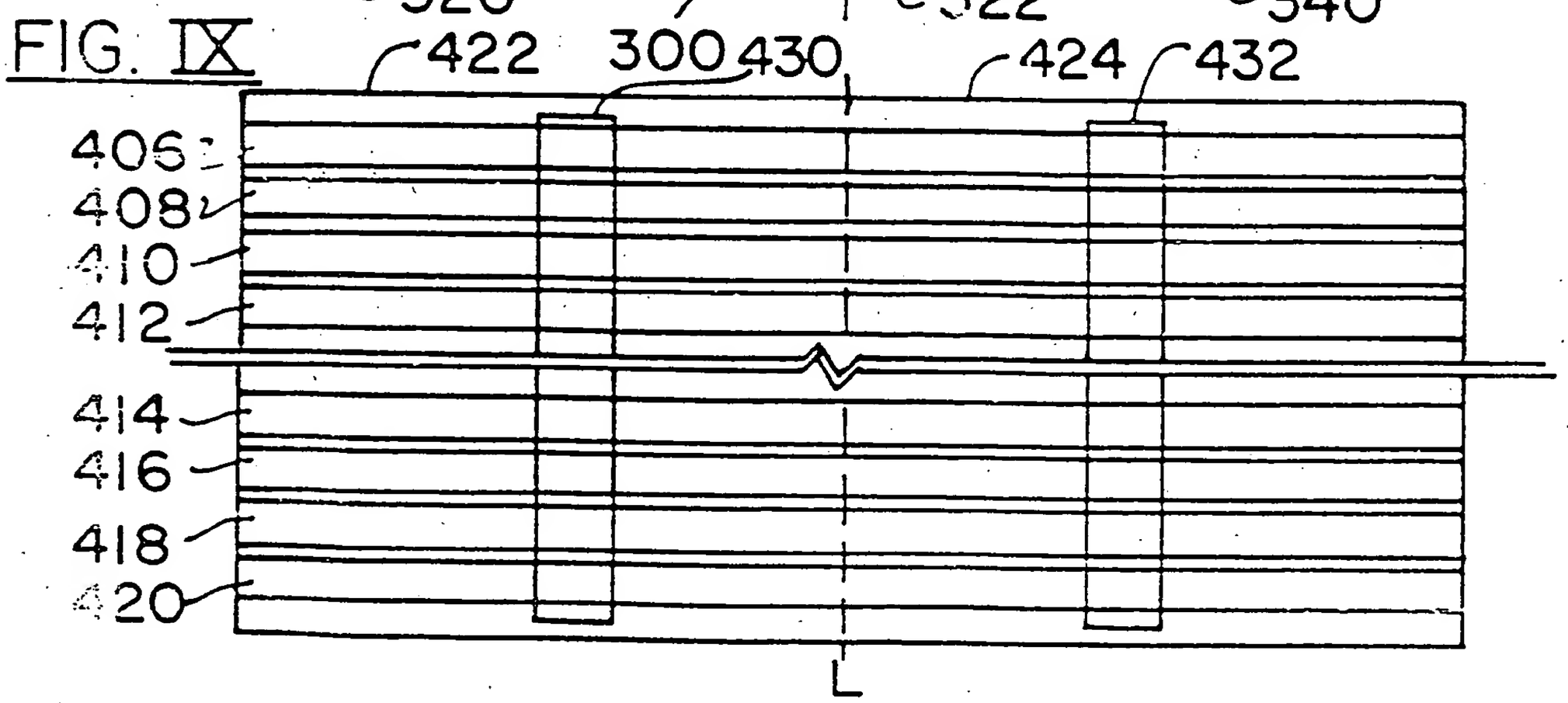


FIG. VIII

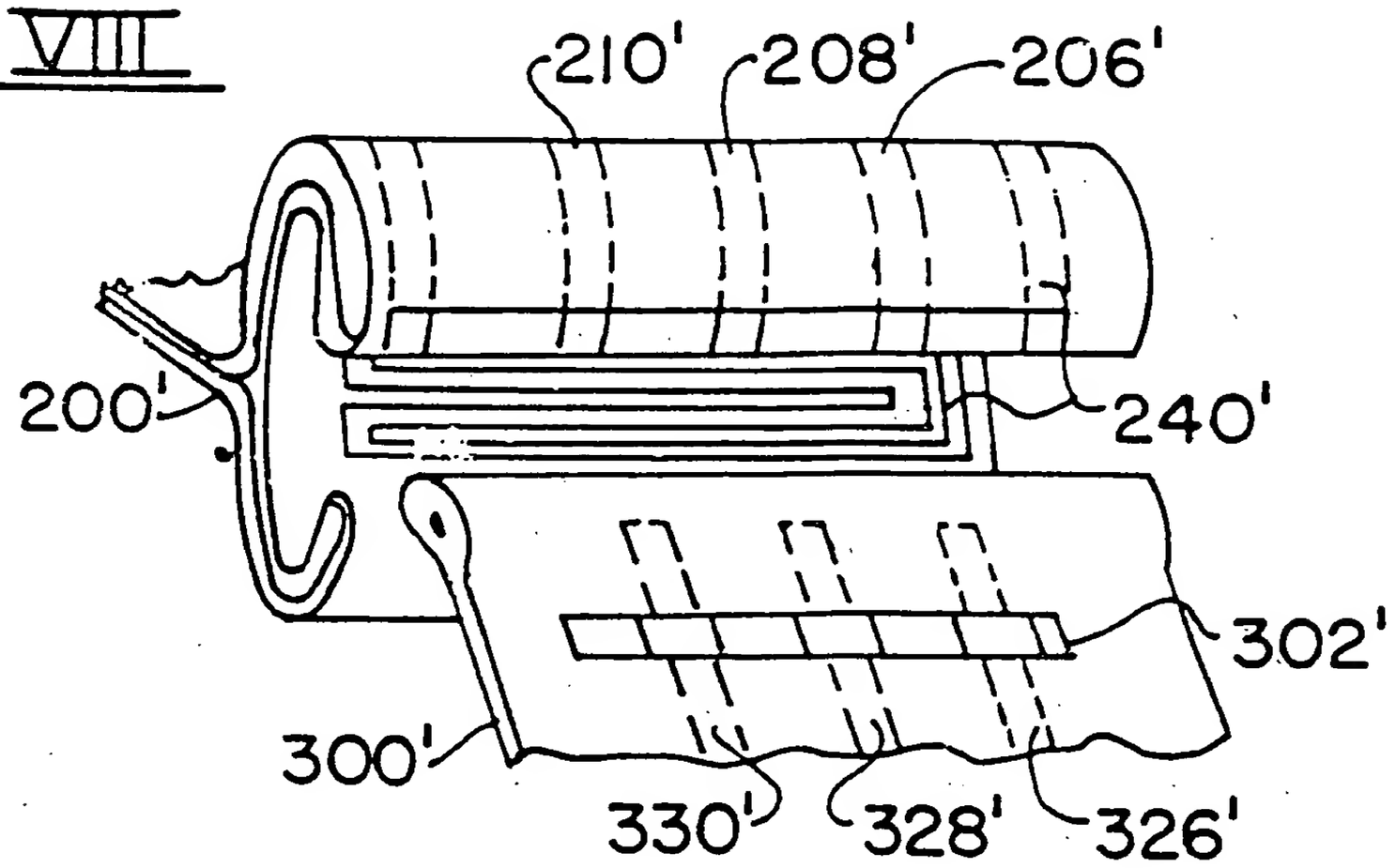


FIG. X

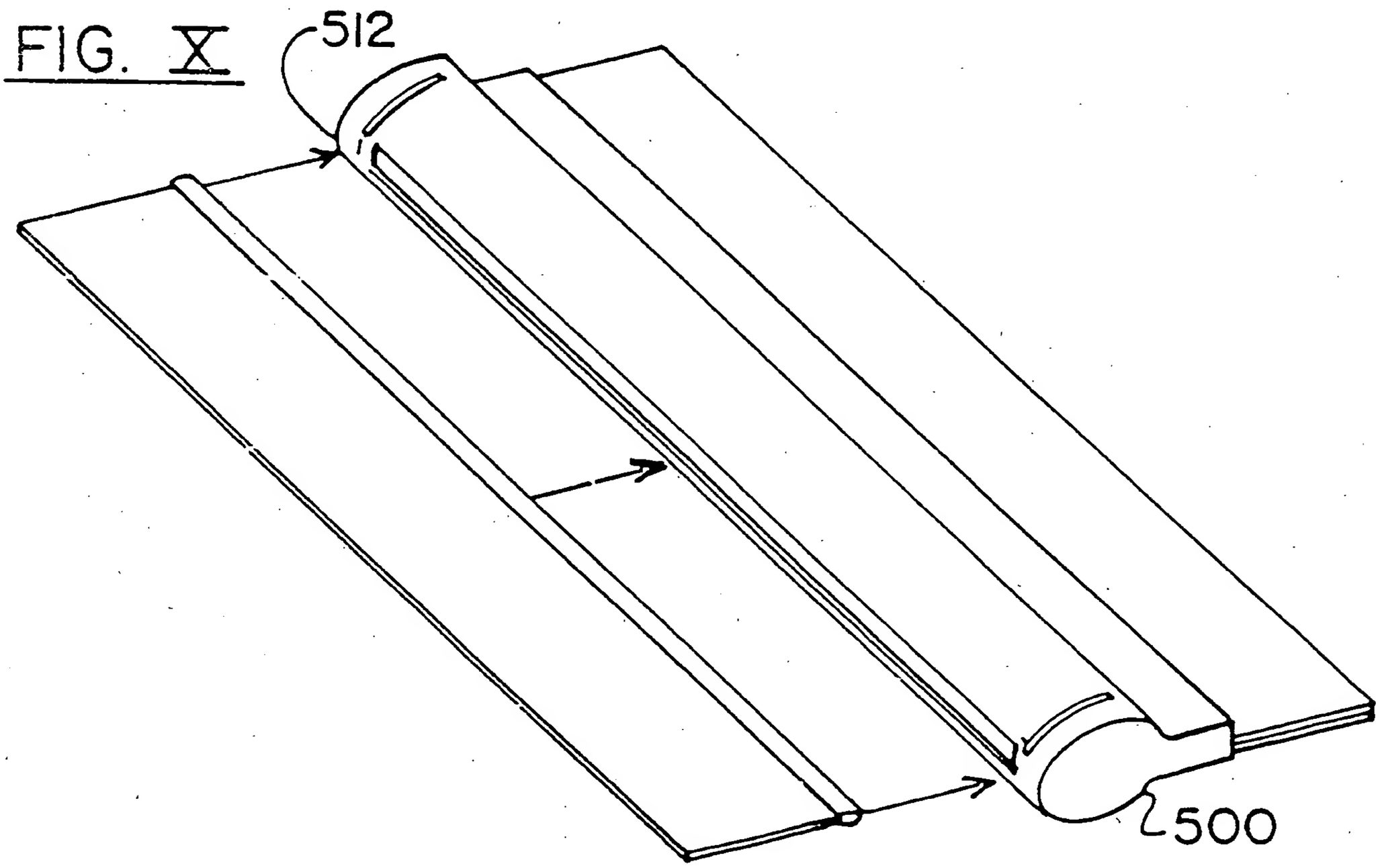
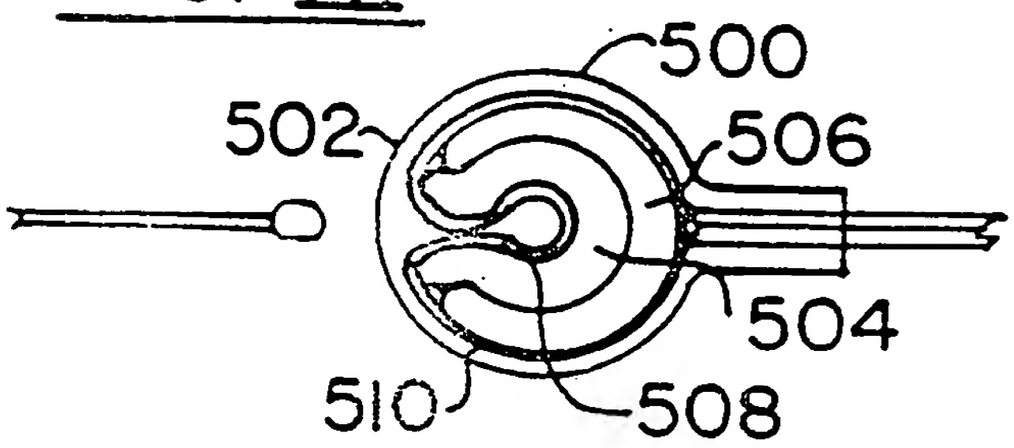


FIG. XI



INTERNATIONAL SEARCH REPORT

International Application No PCT/US85/00873

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.[3] H01R 13/20

U.S. Cl. 339/30

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
U.S.	29/86, 831 339/17F, 30, 59, 60, 61, 176Mf, Dig. 1

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
Y	US, N, IBM Tech. Bulletin Vol. 14 No. 7 December 1971	7, 11, 18, 27 28
A	US, A, 3,569,901 9 March 1971	1-31
Y	US, A, 3,727,173 10 April 1973	1-7, 8-11 13-31
A	US, A, 3,740,839 26 June 1973	1-31
A	US, A, 3,913,444 21 October 1975	1-31
Y	US, A, 4,022,519 10 May 1977	1, 2, 13, 19-21
A	US, A, 4,396,244 2 August 1983	1-31
A,P	US, A, 4,462,651 31 July 1984	1-31

* Special categories of cited documents: [15]

"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
14 June 1985	29 JUL 1985
International Searching Authority [1]	**Signature of Authorized Officer [20]**
ISA/US	Paula A. Austin

Form PCT/ISA/210 (second sheet) (October 1981)